# Plutonium Intakes at the Savannah River Site FB-Line on September 1, 1999

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# FB-Line Intakes Introduction

**Subject:** Pu-239 Release/Worker Intakes

**Contractor:** Westinghouse Savannah River Company

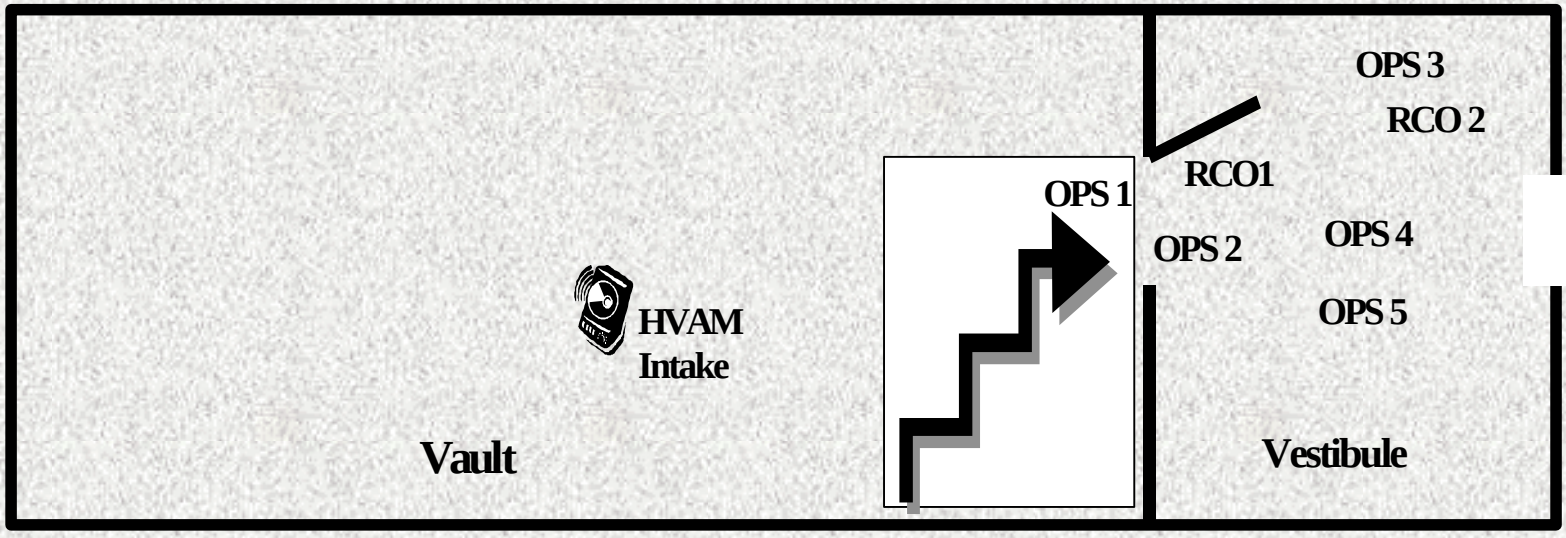
**DOE Coord:** John Pullen, Mosi Dayani

**EH-10 Lead:** Tony Weadock

# Event Overview

- **Defective weld on plutonium storage can led to FB Line Pu-239 release on 9/1/99. Seven workers were working in vault/vestibule preparing cans for transport.**
- **Eight workers (one cross-contamination) received intakes; one in excess of annual limits**
- **Type B Investigation conducted by DOE-SR; report issued 2/2000 (http://tis.eh.doe.gov/oversight/acc_inv/acc_investigations2.html)**
- **EH-Enforcement investigation conducted 4/2000**
- **EA -2000-08 issued 7/2000; PNOV and 220K civil penalty**

# Diagram of Vault/Vestibule Area



# Event Timeline

- **Bagless Transfer Can welded on July 14, 1998, with defect**
  - **Can passed visual inspection and leak checks (gross and helium).**
  - **Can placed in vault on July 14, 1998, and not disturbed (moved or inspected) until September 1, 1999.**
- **Vault evolution on September 1, 1999, considered routine, low hazard work**
  - **Packaging Bagless Transfer Cans in 6M Containers (30 gallon drum) for shipment to 235-F.**
  - **Job had been performed several times without incident.**

# **Event Timeline** (Continued)

- **Pre-job brief conducted at 0830 on 9/1/99.**
- **Personnel proceed to vault at 0945**
  - **PPE: Personnel in vestibule wore full set of protective clothing or lab coat; personnel entering vault wore full set of protective clothing and respirator.**
- **Radcon surveys vault to identify any unusual conditions. Fails to survey racks and does not establish dose rate at the door.**

# **Event Timeline** (Continued)

- **Ops successfully packages two 6M containers, containing two Bagless Transfer Cans each, for shipment to 235-F. Initiates packaging of third 6M.**
- **Ops retrieves faulty can from vault and places on masselin cloth in vestibule**
  - **RWP requires can be surveyed prior to handling by ops.**
  - **Faulty can brought into vestibule for survey. Should have been surveyed in vault.**

# **Event Timeline** (Continued)

- **Radcon surveys show 2000 dpm alpha/100cm$^2$ on can. Ops begins can decon in vault**
  - **RWP vestibule contamination suspension limit of $\geq$ 2000 dpm alpha/100cm$^2$. Evolution should have stopped immediately.**
- **HVAM alarm sounds as Ops begins to decon. Ops returns can to rack and exits vault, pushing vault door closed**
  - **Radcon should have surveyed operator immediately after exiting vault**

# **Event Timeline** (Continued)

- **Radcon inspectors response to alarm.**
  - **Per interview, initially felt alarm was an electrical spike. Made several calls to verify, instead of surveying HVAM planchet.**
  - **Began surveys in vestibule.**
- **Operations discusses requirement to secure the vault**
  - **MC&A/requirements not addressed in procedure.**
  - **Ops FLS not knowledgeable of MC&A requirements under abnormal conditions.**
  - **Confusion as to meaning of “secure the vault”.**

# **Event Timeline** (Continued)

- **Radcon removes planchet from HVAM. Survey finds 80,000 dpm alpha.**
- **Radcon finds contamination in vestibule. Surveys motor air pump filter and measures 80,000 dpm alpha**
  - **Radcon did not notify ops or security of airborne contamination levels in the vestibule.**

# **Event Timeline** (Continued)

- **Ops makes decision to reenter vault and secure rack and vault**
  - **Enters without knowledge or permission of Radcon.**
  - **Enters an airborne radioactivity area without an understanding of whether PPE (full face respirator) would provide adequate protection.**
- **Radcon tells ops they need to leave the vestibule, 18 minutes after alarm**
  - **No sense of urgency, don't crash out.**
  - **All individuals exited in close proximity, creating opportunity for cross-contamination.**
- **Eight intakes (original seven and one cross-contamination) and multiple contaminations (skin or effects) resulted from event.**

# Bagless Transfer System

**Purpose**

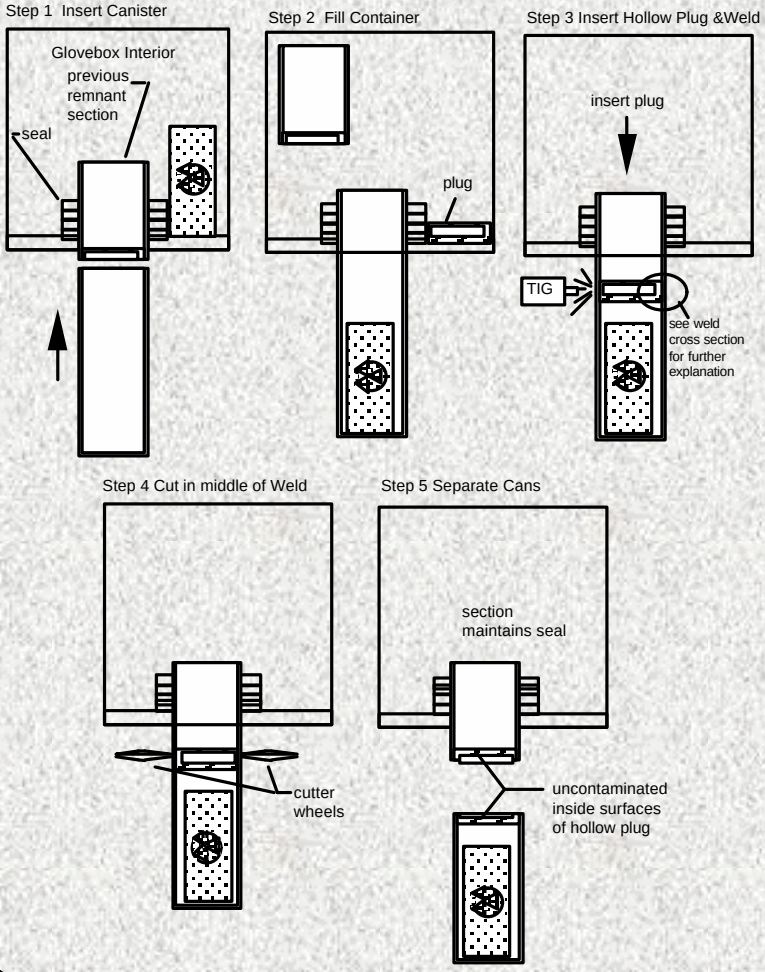
- **To remove plutonium from glovebox and seal it in a welded stainless steel can without contaminating outside of the can.**

**Process**

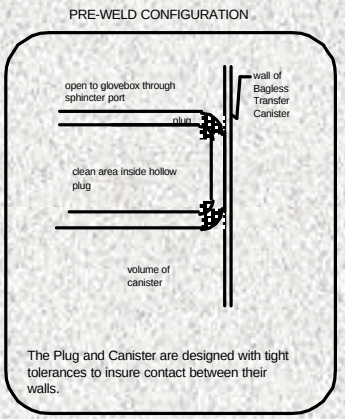
- **Insert new canister into glovebox, displacing previous canister from sphincter seal.**
- **Place plutonium into canister & backfill with Helium.**
- **Insert plug into canister and weld plug to canister, applying three tack welds and overpass weld.**
- **Cut container in center of the weld.**
- **Leave upper portion of canister in sphincter seal to maintain glovebox integrity & remove welded canister containing plutonium.**
- **Weld visually inspected by Operator.**
- **Volumetric and Helium leak check performed by Operator.**

# Bagless Transfer System Overview

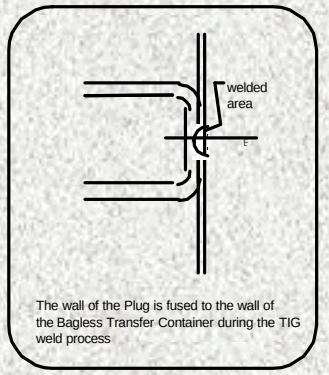
**BAGLESS TRANSFER PROCESS**



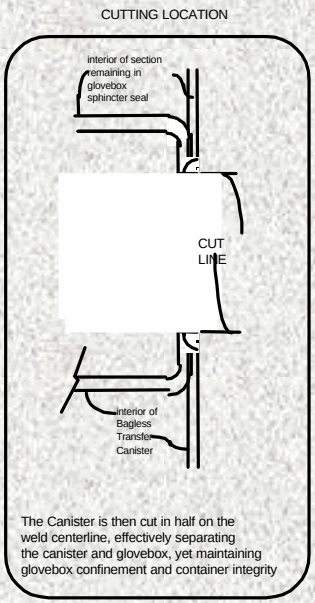

**BAGLESS TRANSFER PROCESS: Weld Explanation**




The Plug and Canister are designed with tight tolerances to insure contact between their walls.




The wall of the Plug is fused to the wall of the Bagless Transfer Container during the TIG weld process




The Canister is then cut in half on the weld centerline, effectively separating the canister and glovebox, yet maintaining glovebox confinement and container integrity

# Weld Defect Failure Analysis

**Failure analysis performed by SRTC with oversight by three outside consultants and AI Board**

**Process**

- **Hole in weld existed at completion of weld.**
- **Oval-shaped hole with ~0.1 inch diameter in can weld at second tack weld.**
- **A lump of excess material was adjacent to hole.**
- **No deviations from specifications found in canister chemical composition, dimensions or cleanliness.**
- **Appearance of weld hole consistent with blow-out during welding.**
- **SRTC could not conclusively determine exact cause of weld failure.**
- **Most likely cause – overpressurization of can during welding (possibly due to lack of venting).**

# Weld Integrity Checks

- Weld defect was created at time of welding and should have been detected.
- Board considered potential failure mechanisms of weld checks
  - <u>Human Factors</u>
    - Weld checks not performed.
    - View of weld obstructed.
    - Operator distracted by plant operation/events during checks.
    - Incorrect operation of leak check equipment.
    - Miscommunication between Operator and Recorder.
  - <u>Quality Assurance</u>
    - Inadequate Operator training for weld inspection/testing.
    - Inadequate maintenance & calibration of leak test equipment.
  - <u>Failure of leak test equipment</u>
    - Board could not conclusively determine reason weld inspection & leak checks failed to detect weld defect.

# Picture of Failed Bagless Transfer Can

# Internal Dosimetry Results

- **Intakes occurred on September 1, 1999.**
- **Intakes occurred through inhalation.**
- **WSRC Dose Assessment**
  - **Thirteen individuals placed on special bioassay program as a result of the event.**
  - **Preliminary and final 50 Year committed effective dose equivalent (CEDE) for 4 individuals:**

| | September 9, 1999 Preliminary CEDE (rem) | January 4, 2000 Final CEDE (rem) |
|---|---|---|
| – OPS1 | 8.8 rem | 1.5 rem |
| – OPS2 | 16.1 rem | 6.7 rem |
| – OPS5 | 5.4 rem | 2.0 rem |
| – RC01 | 2.0 rem | 1.6 rem |

# Internal Dosimetry Results (Continued)

- **WSRC Dose Assessment**
  - **Subsequent to issuance of the Accident Investigation Report, WSRC completed dose assessments for the remaining four individuals identified as having intakes of radioactive material:**

| | CEDE (mrem) |
|---|---|
| • **OPS3** | **667** |
| • **OPS4** | **732** |
| • **RCO2** | **702** |
| • **WSI1** | **<10** |

# Causal Factors

- Quality Assurance
- Integrated Safety Management
- Verbatim Procedure Compliance
- Ventilation System
- HVAM Alarm Response
- Radiological Work Practices
- Abnormal MC&A Response
- Security Post Orders
- Pre-Job Briefs
- Command and Control
- HVAM Operation

# Causes

**Direct Cause**

- **Release of Pu from a defective bagless transfer can that resulted in inhalation by FB-Line workers.**

**Root Causes**

- **Quality Assurance on the bagless transfer can was not adequate to identify the weld defect.**
- **Implementation of Integrated Safety Management for plutonium vault operations was inadequate to provide worker protection during interim plutonium storage and handling. Deficiencies noted in all ISM core function areas.**

# Type B Conclusions

- **Type B Board identified that indicators of existing problems were available to WSRC management for an extended time, and should have enabled implementation of effective corrective actions:**
  - **Previous 1996 F-Canyon intake event involved common failures in procedural compliance, lack of surveys, lack of hazard analysis**
  - **Assessment history at FB-Line indicated continuing problems in radiological controls area. Consistently rated as "below average" by Facility Evaluation Board.**
- **Type B Report identified 16 Judgements of Need to address conclusions reached by Board.**

# Key Factors in Enforcement Decision

- **Significance**
  - **High - one overexposure, multiple intakes, could have been much worse**
- **Identification**
  - **Noncompliance conditions disclosed by event**
  - **Assessment history indicated continuing and similar problems in radcon practices**
  - **Prior can weld defects not formally analyzed**
- **Internal Investigation**
  - **Both WSRC and DOE-SR investigations found to be comprehensive, thorough, largely consistent in conclusions**

# Key Factors (Continued)

- **Corrective Actions**
  - **Corrective actions viewed as broad in scope, with focus on applying lessons learned at both the facility and site level**
- **Prior History**
  - **Severity Level II PNOV in December, 1997 for radiation protection violations resulting in a worker overexposure in 1996**
  - **Both WSRC and DOE-SR's investigations noted similar performance failures between current and previous events**

# Enforcement Outcome

- **PNOV issued July, 2000, with associated civil penalty**
- **Number of apparent violations; consensus to focus on key areas of concern**
- **Overexposure (Severity Level II)**
- **Quality Improvement (Severity Level II)**
  - **Effective processes not in place to ensure weld integrity on bagless cans**
  - **Management processes not effectively implemented to correct identified and long-standing deficiencies in radiological controls**

# Enforcement Outcome
(Continued)

- **Monitoring of individuals and areas (Severity Level II)**
  - **Contamination survey not performed prior to operator handling of bagless cans**
  - **Personnel contamination surveys not immediately performed upon operator exit from vault - no controls established to prevent cross-contamination**
- **Work Processes (Severity Level II ) - Multiple examples in which procedure not followed (RWP suspension limits, notifications, RCO supervisory approval for entry after CAM, etc.)**

# Enforcement Outcome
(Continued)

- **Design and Control (Severity Level III) - Management did not ensure effective physical design features in place. Deficiencies with vault ventilation were well-known and long-standing; compensatory actions were not taken.**

- **Base civil penalty would be $275,000**
  - **No mitigation for identification/reporting**
  - **25% mitigation for four of the violations, based on comprehensive investigation and corrective actions**
  - **No mitigation for overexposure citation**

- **Civil Penalty of $220,000 - uncontested**